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The National Significance of the Augmented Program of Space Exploration

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(Speech before The Commercial Club of Cincinnati, at the Natural History Museum, Cincinnati, Ohio, October 21, 1961)

During the past 60 years our Western society has been dominated by the influence of major developments in science and technology. This period has been marked by the emergency in rapid succession of new fields of engineering and new industries. We passed rapidly from the automotive age to the air age, to the nuclear age, and now to the age of space exploration.

Each of these scientific and technological developments has had a profound impact on every aspect of human affairs. Each provided in essence a mere change in man's physical environment and in the tools which he had at his disposal, but each produced many other changes in his way of life. There were important and direct effects on the economic development of the nation, including the application of the new techniques developed to other branches of industry. There were important contributions to national defense through the application of the new knowledge to military devices. There were major influences on the education of our children and on nearly every aspect of our political and social life. Scientific and technological developments played an increasing role in international affairs. Finally there were important repercussions on human thought and aspirations. Intellectual and spiritual horizons were expanded. Similar widespread effects are to be expected from the development of space science and technology and their application to the exploration of space.

Astronomers remind us that the exploration of space began centuries ago when man began to study the skies. Through the centuries a tremendous amount of information has been obtained by suitable analysis of the light from the stars and celestial bodies which penetrates the earth's atmosphere. However, the recent development of large rockets for military purposes has brought to man the means of sending instruments far out into space for direct measurement, and of venturing himself for short distances to explore and to discover and to learn. Thus we now date the age of space exploration from the launching of the first man-made satellite of the earth on October 4, 1957. In four years man has sent some 65 such artificial moons into orbit around the earth and four in orbit about the sun. The total weight of these objects is more than 75 tons, not much compared with the weight of the moon, but an impressive beginning.

Immediately after the launching of the first Sputnik the United States began the consideration of its role in the exploration of space. During the several months of deliberation by the Executive and Legislative branches of the Government responsibility for formulating an immediate program was temporarily assigned to the Department of Defense.

The National Aeronautics and Space Act was passed by the Congress on July 29, 1958. The Congress declared that it is the policy of the United States that activities in space should be devoted to peaceful purposes for the benefit of all mankind, and set up a civilian agency to implement this policy. Activities in space associated with the development of weapons systems, military operations, or the defense of the United States were reserved to the Department of Defense. Among the objectives set up by the Act were cooperation with other nations in aeronautical and space activities and in peaceful application of the results, and the widest practicable and appropriate dissemination of information concerning the activities of the new agency and the results obtained.

Immediately following the passage of the National Aeronautics and Space Act of 1958 a substantial space program was initiated and aggressively pursued.

From the beginning the U.S. space program has had four general objectives. These are (1) to study the space environment by scientific instruments of many types launched into space by sounding rockets, space probes, earth satellites, and artificial planets; (2) to begin the exploration of space and the solar system by man himself; (3) to apply space science and technology to the development of earth satellites for peaceful purposes to promote human welfare; and (4) to apply space science and technology to military purposes for national defense and security.

The major aims of space science are (1) to study the earth and its atmosphere and the influence of the sun upon the earth; (2) to study the nature of the solar system, including the conditions on the sun, moon and planets, and phenomena in interplanetary space; (3) to search for the possible existence of plant or animal life or life-related substances in the solar system; and (4) to contribute to man's understanding of the origin and nature of the universe as a whole.

The program for the exploration of space by man looks forward to a continually increasing capability and accumulation of experience. I will discuss this program a little later.

The principal applications of earth satellites which have made important progress are weather satellites, communications satellites, and navigation satellites. Results from the TIROS research and development satellite have opened new vistas to the forecaster and research scientist alike, and a TIROS will be kept aloft until the more advanced Nimbus satellite comes into use. Many regard the weather satellite as the most important development in the history of weather observation and forecasting. The time is not far distant when a global communication system will serve remote parts of the world with capability for television as well as telegraph and telephone.

Present applications of space science and technology to military purposes are to early warning satellites and military communication satellites. Other applications will follow as the technology develops and the need arises.

In 1959 a ten-year plan was developed, outlining the various flight missions projected during this period and the major developments in launch vehicles and spacecraft to be accomplished in order to fulfill the stated objectives. Under this plan manned orbital flight was to be accomplished in 1961, impact landing of instruments on the moon, advances in planetary spacecraft, and launching of a prototype active communication satellite in 1962. An orbiting astronomical observatory and an unmanned planetary reconnaissance flight was planned for 1964. In 1965 the prototype of a three-man capsule was to be tested for project Apollo, conceived as one element of an earth-orbiting laboratory and also as a basic vehicle for circum-navigation and manned exploration of the moon. Under the original plan the manned lunar landing mission was considered to lie beyond 1970. This plan involved the expenditure of some twenty to twenty-five billion dollars over the ten-year period.

Following the election of President Kennedy an intensive study was made of the policies underlying the then existing ten-year plan. On March 24th of this year President Kennedy submitted a request for an additional $125,670,000 to speed up the development of large boosters, an area in which we stood at a disadvantage as compared with our competitors in space technology. On May 25th the President in a special message to the Congress on urgent national needs announced major new goals for the nation in space and new programs to achieve them. He stated "I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to the earth. No single space project in this period will be more impressive to mankind, or more important for the long range exploration of space; and none will be so difficult or expensive to accomplish. We propose to accelerate development of the appropriate lunar spacecraft. We propose to develop alternate liquid and solid fuel boosters, much larger than any now being developed, until certain which is superior. We propose additional funds for other engine development and for unmanned explorations -- explorations which are particularly important for one purpose which this nation will never overlook: the survival of the man who first makes this daring flight. But in a very real sense, it will not be one man going to the moon -- if we make this judgment affirmatively, it will be an entire nation. For all of us must work to put him there."

To begin the acceleration of the national space program the President requested appropriations for the National Aeronautics and Space Administration amounting to $1,784,000,000 for fiscal year 1962, but Congress reduced this by about $112,000,000. Funds were included to accelerate the development of large rocket engines and space vehicles, for speeding up exploration of the environments of the earth and of the moon and the space between, to expedite the Rover nuclear rocket engine, to expedite the development of an active communication satellite system, and to accelerate the development of the technology needed for manned flight to the moon and return to the earth.

The goal of the present project Mercury is to fly a man for three orbits around the earth and to recover him safely. We expect to accomplish this mission late this calendar year or early next year. The follow-on project to accomplish the goal set by the President, i.e., the landing of three men on the moon's surface and the return of these men safely to earth within the coming decade, is called Project Apollo. A preliminary analysis of this project shows more than 2000 tasks that must be accomplished, ranging from the development of new large boosters and the launching facilities necessary to send them into space to experiments on the biological effects of the radiation encountered in space and the study of satisfactory methods of protection, and the engineering development of heat shields for reentry speeds as high as 25,000 miles per hour. Along the road are three major milestones to qualify the capsule and crew for the lunar mission. We are now in the process of evaluating proposals submitted by prospective teams of contractors to design and build the spacecraft that we will eventually use for the lunar landing. We will first launch this capsule into an orbit about the earth in order to check out the equipment under conditions such that, in the event of failure, the crew can be returned safely to earth. When the capsule is satisfactory for this mission we can add to it a rear section which can be used as a space laboratory for investigation of technological and biological problems in the space environment.

We then proceed to launch the spacecraft in elliptic orbits extending out from the earth until finally we send the capsule around the moon and return it to the earth. This circumnavigation of the moon is one of the important milestones. In this mission the capsule can be qualified under the high speed of reentry from the distance of the moon.

We are using a "building block" concept for the several missions. For the final mission to send men to the moon and return it is necessary to add a propulsion section to slow down the capsule for landing on the moon and a second propulsion section for returning the capsule from the moon to the earth.

While the accelerated program is described in terms of the mission of manned exploration of the moon, it is important to realize that the setting of this goal has as its primary purpose a great cooperative national effort to develop space science and technology, which can then be applied to meet both civilian and military objectives. The billions of dollars required in this effort, spent in the laboratories, workshops and factories of the nation, will insure the nation against technological obsolescence in a world of explosive advances in science and technology and against the hazard of military surprise in space. The specific goal set by the President has the highly important role of motivating the scientists and engineers who are engaged in this effort to move forward with urgency, and of integrating their efforts in a way that cannot be accomplished by a disconnected series of research investigations.

The accelerated space program has major significance for the economic development of the nation. Manned exploration of the moon requires the most advanced engineering and technological developments of our time at the very frontiers of knowledge. Major advances are occurring in electronics and communications, new materials, energy sources and energy conversion devices, data collection and handling, computers, knowledge of the behavior of the human body under stress, protective environment for man, and many other areas.

These developments at the frontiers of science and technology are transferable to other applications in industry. Because of the newness of the space age it is difficult to give specific examples at this early date. It is easier to recognize this process in relation to the automotive age, the air age, and the nuclear age. For example, the development of the automobile has brought us the concept of simplification for the operator through complication of design, a concept now widely applied in the operation of a modern

steel mill or oil refinery and in such modern consumer products as automatic washers and ovens, where automatic controls program the entire operation. The automobile is largely responsible for the development of alloy steels, new fuels, synthetic rubber, quick drying finishes, and other new materials.

Similarly the air age brought us great supplies of aluminum and the basis for building light-weight structures, not only for airplanes but also for trains, buses and ships. The nuclear age brought applications of isotopes in medicine and in the inspection of materials. Nuclear developments brought remote manipulators and sealed pumps for hazardous liquids and gases. The space age has brought to maturity the concept of systems analysis and optimization of designs involving many branches of science and engineering. In addition the space age has given us high temperature ceramics, ablating materials for heat protection, pressure stabilized light-weight tanks, computers handling large amounts of data, and many other developments which are finding applications throughout industry.

While the technological developments offer the earliest contributions to economic development, in the long run the contributions from the scientific knowledge obtained in the great unknown environment of the celestial bodies and interplanetary space may bring much greater returns. Today not only the prestige of a nation but also its true greatness and strength depend upon mastery and control of man's physical environment; and the extension and perfection of scientific knowledge is fundamental to that mastery and control. What benefits the new knowledge of the universe may ultimately bring to mankind no one today can predict. Judging from past experience advances in scientific knowledge are the foundation of advances in technology and advances in technology are a key factor in economic development.

The exploration of space has already had significant effect on our educational system. The launching of the first satellite by the USSR brought to a head a movement to reexamine and improve the teaching of science and engineering in colleges and universities which had its roots in the tremendous expansion of military research and development in the birth of the new technologies of nuclear powered rockets and guided missiles. The criticism and examination of the educational system extended to elementary and high school teaching of science, mathematics and English, as well as to the whole content of the curriculum.

The impact of space exploration on education may be summarized as: (1) a demand for the training of more scientists and engineers to meet the needs of the expanding role of science and technology in the modern world; (2) a demand to recognize the presence of various levels of intellectual ability by adapting the content of the curriculum, teaching method, and the rate of progress to the needs of the several groups; (3) a demand for revision of the course material by scientists and educators working in collaboration; (4) a demand for better trained teachers qualified in the subject matter as well as in educational techniques; and (5) the wider teaching of general courses in science as a part of the cultural heritage of every educated person.

In the training of scientists and engineers the trend is from specialized courses to more basic courses. Thus an engineer thoroughly grounded in the basic principles of heat transfer and familiar with experimental data on the physical constants can apply his knowledge to new situations and new technologies, to the cooling of a radar transmitter tube, a nuclear reactor fuel element, or to a satellite and its equipment in the space environment. In the training of graduate students by participation in research the great emphasis is now on interdisciplinary groups applying the techniques of the several basic sciences to typical problems at the frontiers of knowledge.

The national defense and security in the space age has been the subject of much study and discussion. The freedom of space combined with the great power of nuclear energy for destruction forecasts the future development of weapons systems now only dimly understood. There are many applications already evident and under way as a responsibility of the Department of Defense.

Space exploration is a significant factor in international policy. One of the most interesting happenings in space today is the growing development of international cooperation in space exploration on a wide scale. The United States is cooperating with a growing number of nations in a variety of projects to increase knowledge of the earth's environment and of the universe and to realize the practical benefits of applications of space science and technology to peaceful purposes. We are conducting our experiments in the open. We are sharing our discoveries with the world community.

In March 1959 the United States offered through the Committee on Space Research of the International Council of Scientific Unions to cooperate with other nations in making available launching vehicles, spacecraft, technical guidance, and laboratory support for orbiting individual experiments for complete satellite payloads developed in other countries. The first satellites under this international program are being prepared by the United Kingdom and Canada and will be launched in the first half of calendar year 1962. Discussions are in progress with several other governments which have expressed interest in cooperative satellite projects. Cooperative space research is by no means limited to the more expensive satellite projects. Much valuable information can be obtained from the relatively cheap sounding rockets and such joint programs are under way with many countries.

In his recent speech before the United Nations President Kennedy said: "We shall urge proposals extending the United Nations Charter to the limit of man's exploration in the universe, preserving outer space for peaceful use; prohibiting weapons of mass destruction in space and on celestial bodies, and opening the mysteries and benefits of space to every nation. We shall propose further cooperative efforts between all nations in weather prediction and eventually in weather control. We shall propose, finally, a global system of communication satellites linking the whole world in telegraph and telephone, and radio and television."

Some social scientists have speculated that the exploration of space might become in time a substitute for war. Hope would be that the absorption of energies, resources, imagination and aggressiveness in the exploration of space might contribute to the maintenance of peace. Whether or not this speculation is warranted, I am sure from personal experience that international cooperation in the exploration of space does contribute to friendship and understanding among nations.

The influence of space exploration extends far beyond scientific, technological and economic development, education, and international relations. No area of human activity or thought has escaped, government, law, ethics, religion, in fact all human thought and aspirations. Even in the USSR we are told of the complaint of the Russian workman, who asked, "What do Sputniks give to a person like me?" The Sputniks can give everyone an expansion of his intellectual and spiritual horizons as he takes a longer view of man's role in time and space.

The large distances involved, long known to us from the work of astronomers, strike us with new force as we consider traversing them. Our nearest neighbor the moon, the immediate goal of the accelerated space program for this decade, is about 240,000 miles away. The nearest planet to us is Venus at 26 million miles; the next, Mars, at 49 million miles. The farthest planet, Pluto, is 3,680 million miles from the sun. The sun itself is 93 million miles from the earth.

To comprehend these tremendous distances by earth's standards, let us suppose that we had a manned spacecraft suitably equipped that could maintain its speed continuously at the burnout speed of the space probe Pioneer V, nearly seven miles per second, or 85 times the speed of a jet transport. It would take us about eight hours to reach the moon, 81 days to Mars, 153 days to the sun, and about 16 years to Pluto.

The nearest star is 25 quadrillion miles away, and travel to it at seven miles per second would require more than 100,000 years. Is travel of man to the stars then a futile dream? The vast reaches of the universe, our sun, the earth, the planets, the galaxies of stars have continued in their courses for billions of years before man appeared. Man is so tiny, his power so infinitesimal compared to the great forces of nature. Yet since the invention of writing, each generation of men builds on the shoulders of the past. The exploration of space has begun; who now can set limits to its future accomplishment?

Let's return from dreams to the earth and reality, from the future to the present. The exploration of space will go forward, if not by us, then by others. It is inconceivable that the United States will shrink from its proper role in the exploration of the new frontier regardless of the difficulties, costs and hazards. The hazards of not exploring are still greater -- the hazard of future technological obsolescence, the hazard of potential loss of leadership, the hazard of military surprise by potential enemies, if we fail to act. One of the participants in a forum at the recent Space Flight Report to the Nation by the American Rocket Society in New York was asked his opinion of the one single step which could do most to advance the space program of the United States. He replied, "The President of the United States has set for us a national goal. Let us go forward!"

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